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PARKS-HILBERT TRANSFORMS STATISTICAL PARAMETERS APPROACH TO CLASSIFY ANN NETWORK

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ABSTRACT

Due to the cardinal features like robustness, efficient load handling, reliability etc the Induction Motor is foremost used for number of applications. While working environmental conditions, mechanical stresses etc cause fault like bearing fault, inter-turn short circuit fault, rotor bar crack. These faults should be eliminated and categorized as early as possible to avoid harm. There are list of techniques are accessible for the fault catalogue of I.M. The Artificial Neural Network is the best solution over other existing techniques. The motor line currents recorded under varied faults conditions were analyzed using ANN.

Keywords: I.M., Park's-Hilbert Transform, FFT, Statistical Parameters, ANN (networks)

I. INTRODUCTION

Nowadays, Induction Motor has their wide usage in industrial and commercial sectors. But the induction motor undergoes several drawbacks while working due to mechanical stresses and environmental conditions. Failure survey have reported that the percentage of failure by components of induction motor as, [3]

(1) Stator related-38%

(2) Rotor related-10%

(3) Bearing Related-40%

(4) Other-12%

These faults conditions should be detected classified and clarified as much as possible. The fault should be clear in its minor state for maintaining its reliability, minimizing losses and expenses, etc. The fault may cause unexpected and sudden breakdown of motors.

There are ample techniques and methods of classification of faults have been developed now. But ANN is accepted as one of the best working techniques. The obtained result gives the crystal clear idea about its suitability of proposed techniques to acquire 100% accuracy for multiple fault categorizations.

The foremost behoof of ANN is that it derives the online cognition libidinous the kind and size of culpability outside possessing very daedal mathematical models. If the element of Neural Network flops,it can wage without whichsover exigency by theirparallel disposition.

II. PARK'S-HILBERT TRANSFORMATION

2.1 Park's Transform:

Acquisition of three phase currents(I_A,I_B, I_C) at different loading and faulty conditions. As a function of mains phase variables (I_A,I_B, I_C) the motor current park's vector components (I_D,I_Q) are,[1] [5] [6]

$$I_D = \left(\frac{\sqrt{2}}{\sqrt{3}}\right) I_A - \left(\frac{1}{\sqrt{6}}\right) I_B - \left(\frac{1}{\sqrt{6}}\right) I_C \text{-------- [1]}$$

$$I_Q = \left(\frac{1}{\sqrt{2}}\right) I_B - \left(\frac{1}{\sqrt{2}}\right) I_C \text{----------[2]}$$

The Park's transform is a simple and efficient diagnosis method. It is based on the spectral analysis of Park's Square Vector (PSV) that is computed as,

$$\text{PSV}=\sqrt{{I_D}^2 + {I_Q}^2} \text{---------- [3]}$$

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2.2 Hilbert Transform:

Computation of three analytical signals ($\bar{I}_A, \bar{I}_B, \bar{I}_C$) using Hilbert approach.[3]

HT(x(t))=$y(t) = \frac{1}{\pi}\int_{-\infty}^{+\infty} \frac{x(\tau)}{(t-\tau)} d\tau$ ----------[4]

Park's-Hilbert approach is based on the spectral analysis of $PSVM_{(P-H)}$ that represents the Park's square vector modulus computed starting from amplitudes of three phase currents analytical signals obtained by Hilbert Transform.[6] [7]

$$I_{D(P-H)}(t) = \sqrt{\frac{2}{3}}|\bar{I}_A(t)| - \sqrt{\frac{1}{6}}|\bar{I}_B(t)| - \sqrt{\frac{1}{6}}|\bar{I}_C(t)| \text{ -------- [5]}$$

$$I_{Q(P-H)}(t) = \sqrt{\frac{1}{2}}|\bar{I}_B(t)| - \sqrt{\frac{1}{2}}|\bar{I}_C(t)| \text{------[6]}$$

Computation of $PSVM_{(P-H)}$ by using $I_{D(P-H)}(t)$ and $I_{Q(P-H)}(t)$ as follows,

$PSVM_{(P-H)} = I^2{}_{D(P-H)} + I^2{}_{Q(P-H)}$ -------[7]

III. FAST FOURIER TRANSFORM (FFT)

A FFT is a contrivance to reckon the discrete time Fourier transform and its inverse. A FFT catechumen time to frequency and contrariwise. FFT have been ascribed as the puissant numerical algorithm of our lifetime. In the dubiety of round off error FFT Algorithm are aggrandize scrupulous than assessing DFT.

Let,

$X_{0,} - - - - - -, X_{N-1}$ Be complex no.

The DFT is defined by,

$$X(k) = \sum_{N=0}^{N-1} x(n) e^{\frac{-j2\pi nk}{N}}$$

Where,

k= 0,----------, N-1

Many FFT algorithms only depend on the fact that $e^{-2\pi j/N}$ is an primitive root of unity. The relevance of FFT is to dichotomize the transform into N/2 at each step. The power spectrum is computed from FFT function as the mean squared amplitude at each frequency line.Vantage of FFT includes fast large integer and polynomial multiplication, matrix vector multiplication, detection of types of motor faults, etc.

IV. ARCHITECTURE OF ANN

The typical ANN includes input layer, hidden layer and layer of neurons. Input layer is seize data, signals, features or measurement from external environment and hidden layer excerpt the patterns affiliate with the process being confab. This layer comply the visceral processing from the network and then output layer fruitage and present the final output which backwash from processing transact by the neurons in anterior layer. Exclusive neuron is an autarchic processing unit that transforms its input data via function called activation function. The ally between neuron is characterized by weight values that typify the memory of network.[5] [6] [7]

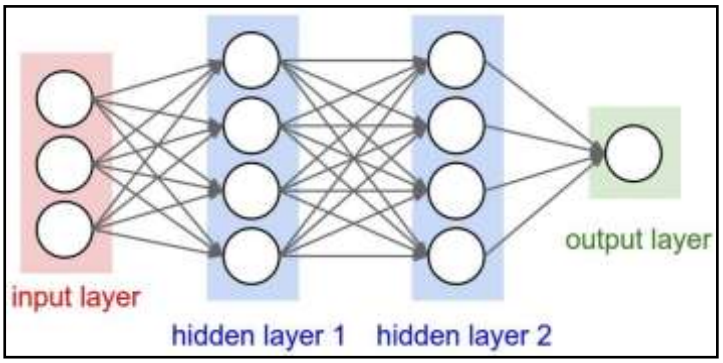

Fig. 1. Architecture of ANN

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V. EXPERIMENTAL SETUP

To examine the fault of induction motor at high accuracy level, the connection of experimental setup is as shown in fig.5

Fig. 2 Experimental Setup

The faults in induction motor are discriminate with high recognition rate for which model laboratory setup consist of 2 HP, 3-Ø, 50 Hz squirrel cage Induction motor with electrical is used. Inter-turn short circuit faults (10-T) and bearing defects (Inner race and outer race) etc is examined with the help of resistive load arrangement of induction motor electrically coupled with DC shunt generator. The 3-Ø stator current signalsI_A, I_B *and* I_C captured with voltage V_A the ADLINE data card, with 1 KHz sampling were used to capture the current. Accession of various data sheets at distinct condition can be done by the experimental setup. The main target of experimental setup is to determine the current rating of I_A, I_B, I_C under distinct conditions such as healthy and faulty condition.[6][7]

VI. TYPES OF NEURAL NETWORKS

[A] Multilayer Perceptrons

The Multilayer Perceptions (MLPs) one of the feed forward artificial neural network. It comprise of three or more layer (input, output and hidden layer). Each flake is associated with coherent weight multi layer perception network directed graph in which all neurons of one layer are fully aggutinate to all other neurons of next layer .this network uses supervised acquising treat when it has set of training data.

The supervised learning algorithm consists the desired outturn of the all training example. Back propagation algorithm is used to train the data set to predict the error. The error contracted from this algorithm is the difference betwixt sooth and desired output. As a result of inuring the pruning algorithm the network size become curtailed and it avert unwanted complexity but the key disadvantages are that they train slowly, and require lots of training data (typically three times more training samples than network weights).

Table 6.A

Faults	PE	Statistical Parameters		
		7	9	**11**
H	7	0	0	**100**
B		100	100	**100**
IT		71.42	0	**100**
MSE		0.082	0.3153	**0.1331**

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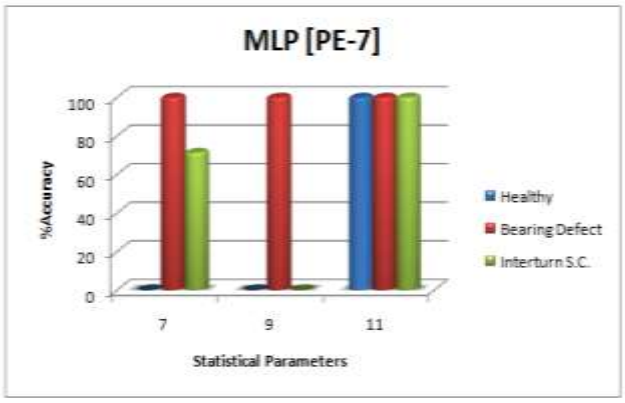

Fig. 6.A.1. %Accuracy Vs SP of MLP

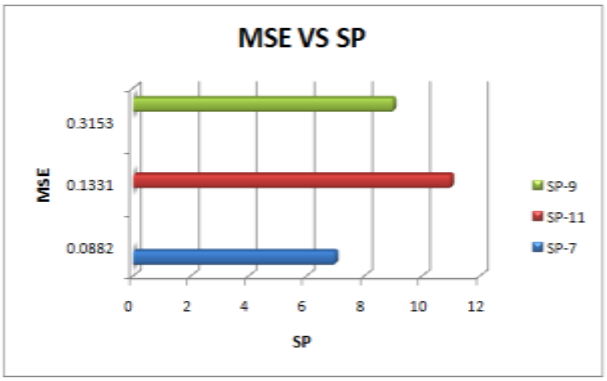

Fig. 6.A.2.MSE Vs SP of MLP

[B] Generalized Feed Forward

Feed forward neural networks are eversion of MLP such that every neuron in each layer agglutinates to the next forward layer. The great prevalence is colossal computation speed , as a result of parallel structure a generalized feed forward neural network with enough neuron in hidden layer can appurtenant for any functional mapping problem. Usually, generalized feed forward network demands hundreds of times less training epochs than the standard MLP containing the same number of processing element.

Table 6.B

FAUTLS	PE	SP
		7
H	8	100
B		100
IT		100
MSE		0.1113

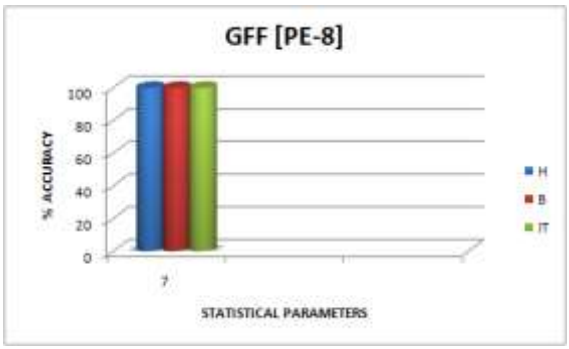

Fig. 6.B.1 %Accuracy Vs SP(7) of GFF

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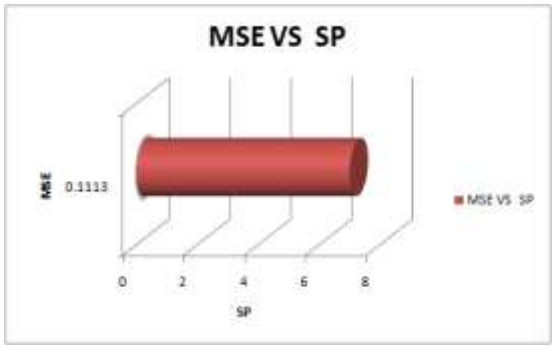

Fig. 6.B.2. MSE Vs SP

[C] Jordan/Elman Network

Jordon/Elman's network feeding akin as feed forward neural network (FFNN) but diversification is context layer. Context layer is called as memory unit because they recurrence past event. Jordan network bunch past values of context unit with the present input to contract the present net outturn. The input to the context unit transcript from network layer, but the output of the context unit is mingle in net through adaptive weight. Neuro solution users erect back propagation to adapt all the network weight. In the neural builder the context unit 'T' constant is pre-selected by user but we can bare leash the time constant. Moreover the broom after change in 'T' is reflected enormous change in weighting.

Table 6.C

Faults	PE	Statistical Parameters			
		7	9	11	**14**
H	10	0	0	0	**100**
B		100	100	100	**100**
IT		75	100	50	**100**
MSE		0.0625	0.0076	0.0055	**0.0044**

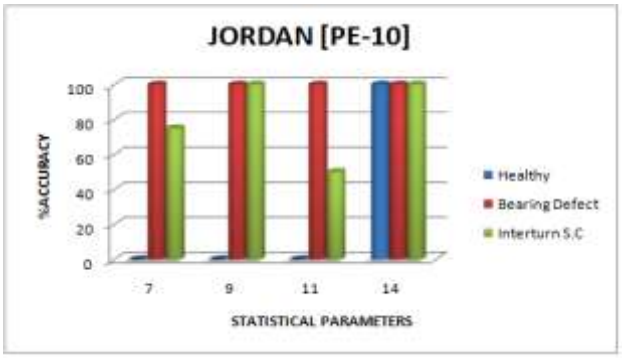

Fig. 6.C.1. % Accuracy Vs SP of Jordan

Fig. 6.C.2. MSE Vs SP

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VII. RESULTS AND DISCUSSION

The ANN is pre-eminent networks with its outstanding exempler endorse system implement for memorandum the fault of induction motor. It comprise of various networks as MLP, GFF(FFNN), Jordan, etc.

MLP Network with 11 SP, 7 PE, 1 hidden layer, minimum MSE of 0.1331 gives 100% accuracy.

That of GFF gives 100% accuracy with 7 SP, 8 PE, 1 hidden layer and minimum MSE of 0.1113.

And Jordan network attains 100% accuracy at 14 SP, 10 PE, 1 hidden layer having minimum MSE of 0.0044.

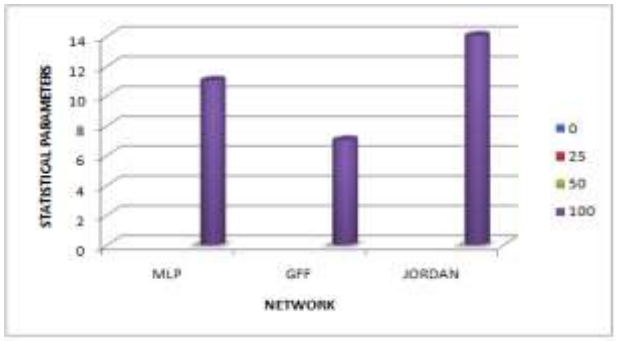
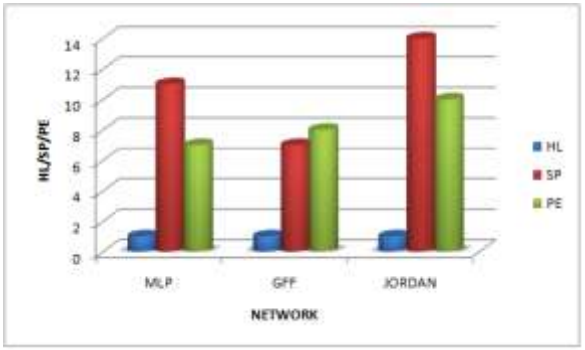


Fig.7. 100% Accuracy of different networks

VIII. CONCLUSION

Above work deals with various networks of ANN, under which MLP, GFF and Jordan networks are to be run to give the 100% accuracy. But amongst them the Generalized Feed Forward (GFF) Neural Network is the excellent network for discrimination of faults. GFF working with TanhAxon (a member of Axon family) gives 100% accuracy with least no of statistical parameters (here SP=7) as shown in graph below.



Comparison of ANN Networks

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